

Journal of Endodontics, 1995, Vol. 21

OCTOBER

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Cytotoxicity of four root end filling materials

Torabinejad M, Hong CU, Pitt Ford TR, Kettering JD. Cytotoxicity of four root end filling materials. J Endodon 1995;21:489-92.

PURPOSE: To compare the cytotoxicity of amalgam, Super EBA, IRM, and MTA on mouse L929 fibroblasts.

M&M: L929 mouse fibroblasts were grown in Dulbecco's minimal essential medium. Sybraloy amalgam, Super EBA, IRM, and MTA were mixed and placed into high density polyethylene (HDPE) tubing, cut into 5-mm-long rings. Freshly mixed and 24-h set materials were tested. L929 cells were grown utilizing an agar overlay method modified from the technique described by Okita and Hensten-Pettersen, 1991. Freshly mixed and 24-h set test materials with their HDPE rings were placed onto the agar overlay and incubated for 24 h at 37° C, and then the cultures were examined for cytolysis, with zones of inhibition measured with a mm ruler. In addition, a radiochromium release cytotoxicity technique was used to test 5- to 7-day-old L929 cells. In this test, monolayer cells were labeled overnight with ⁵¹Cr supplied as sodium chromate. Test materials were mixed and placed into 5-mm HDPE rings, which were placed into culture wells. Two ml of labeled L929 cells were dispensed into each well and incubated for 4 and 24 h at 37° C. Following incubation, 1.5 ml of culture medium was withdrawn from each well and transferred to a test tube, which was centrifuged. Samples were counted for 2 min in a gamma counter and the % of ⁵¹Cr released in the test samples calculated.

RESULTS: Zones of lysis around freshly mixed amalgam and Super EBA were sig larger than those around their set mixes. No sig difference was found between zones of lysis around freshly mixed and set MTA. The average zone of lysis around set IRM was sig larger than that around freshly mixed IRM. Fresh amalgam was sig less toxic than the rest of the tested materials. Fresh MTA was less toxic than Super EBA or IRM. Fresh Super EBA was sig less toxic than freshly mixed IRM. Set amalgam was less toxic than Super EBA, IRM, and MTA. Set MTA was sig less toxic than set Super EBA or IRM, and set Super EBA was sig less toxic than set IRM. There was a sig difference between the toxicity of freshly mixed materials after 4 h of incubation with ⁵¹Cr-labeled L929 cells, with freshly mixed amalgam and Super EBA having similar toxicity but sig less than freshly mixed MTA and IRM. Freshly mixed MTA was sig less toxic than other test materials after 24-h of incubation. The percentages of cellular lysis for fresh and set materials were sig higher following 24 h of incubation than following 4 h.

C&C: All freshly mixed root end filling materials were cytotoxic as shown by the agar overlay method, with amalgam the least cytotoxic, followed by MTA, IRM, and Super EBA. This order was amalgam, MTA, Super EBA, and IRM when set materials were tested. The data from the radiochromium release method showed mild to moderate toxicity for fresh as well as set materials after 4 h. After 24 h, the degree of cytotoxicity for fresh and set materials in descending order was MTA, amalgam, Super EBA, and IRM. As previous cytotoxicity studies have surmised, released eugenol may be responsible for the toxicity of IRM and Super EBA. Based on these results, MTA passes the cytotoxicity in vitro tests and comes a step closer to being marketed.

October 1995

Michael Hall

Properties of endodontic hand instruments used in rotary motion. Part 2. Instrumentation of curved canals

Schäfer E, Tepel J, Hoppe W. Properties of endodontic hand instruments used in rotary motion. Part 2. Instrumentation of curved canals. J Endodon 1995;21:493-7.

PURPOSE: To investigate the shaping abilities of different endodontic hand instruments, which are primarily designed for a rotating working motion.

M&M: Endodontic hand instruments (25 mm) were tested under standardized conditions, using a computer-driven testing device with a working motion analogous to manual root canal "reaming". During each working cycle, the instrument first passively penetrated into the simulated resin root canal (42° curvature, 5.5 mm radius), made a 110° clockwise rotation after it had come into contact with the canal wall, and was removed from the canal after the rotation had been finished. Each canal was photographed before and after instrumentation, to be used for measurement of the material removed along both inner and outer canal walls at various points. Penetration depth of instruments into canals was continuously recorded. Tested instruments (see below) were used to enlarge 12 simulated canals from size #15-#35 (one instrument/canal).

RESULTS: Undesirable changes in the canal shape occurred in all cases. None of the instruments was able to remove material on the entire length of the inner side of the curvature, whereas all instruments removed material on the outer side. Nitinol K-files (Mity, NiTi, Texceed) did not remove material in the last 3.5 mm of the inner side of the canal. The average loss of working length (WL) ranged between 3-3.3 mm. Stainless steel (SS) reamers and K-files (Antaeos, Kerr, Maillefer) removed large amounts of material from the last 5 mm of the outer wall, resulting in severe bulging. No material was removed in the last 3.5 mm of the inner wall, and the average loss of WL ranged 2.6-3.6 mm. SS flexible instruments with conventional tips (Flexicut, K-Flex, Flexoreamer, K-Flexofile) removed outer wall material mainly in the last 1-4 mm, resulting in moderate bulging. Inner walls were not touched in the last 1.5 mm and the average loss of WL was 1.7-2.3 mm. **SS flexible instruments with modified tips** (Flexoreamer Batt tip, K-Flexofile Batt tip, Flex-R) removed material along the whole length of the outer side, as well as the inner side, except for the last 1 mm. Straightening was very slight and loss of WL averaged 1.4-1.8 mm. These were judged to give the best instrumentation results.

C&C: This nicely standardized investigation confirmed claims that flexible SS instruments have better shaping abilities than conventional SS instruments. Also, the modified, noncutting tipped-files caused fewer undesirable changes in the curved canal than the conventional cutting tips. Nickel titanium K-files wore very rapidly, and removed very little material from the resin canal walls.

**October 1995
Bates**

Christopher F.

Apical sealing ability of a new glass ionomer root canal sealer

Goldberg F, Artaza LP, De Silvio A. Apical sealing ability of a new glass ionomer root canal sealer. J Endodon 1995;21:498-500.

PURPOSE: To compare the sealing abilities of Tubli Seal, Ketac Endo, and Ketac Endo after removal of smear layer in teeth obturated with laterally condensed GP.

M&M: 35 max central incisors and canines were used. Crowns were removed, and all teeth were instrumented at working length to a #45 file. The teeth were randomly divided into 3 groups of 10. Group A teeth were obturated with Tubli Seal in conjunction with GP; group B teeth were obturated with Ketac Endo (and GP); group C teeth were treated with 10% polyacrylic acid for 10 s using a sonic device to remove the smear layer before obturation with Ketac Endo (and GP). Teeth were stored for 7 days, the root surfaces were coated with 2 layers of nail varnish except the apical 2 mm, and the teeth were placed in India ink for 7 days. The teeth were decalcified and cleared, and extent of ink penetration was measured.

RESULTS: In group A, dye penetration ranged from 0.00 mm to 0.94 mm, with a mean of 0.14 mm. In group B, the values were 0.00 to 1.05 mm, with a mean of 0.24 mm. In group C, the values ranged from 0.00 to 1.26 mm, with a mean of 0.48 mm. No statistically sig differences were seen among the groups.

C&C: These results indicate that the use of 10% polyacrylic acid in an attempt to remove the smear layer prior to using Ketac Endo did not improve its sealing ability. As always, caution must be used in extrapolating in vitro dye leakage tests to the clinical situation.

**October 1995
Hall**

Michael

Three computer methods to reconstruct pulpal blood vessels and nerves

Lyroudia K, Nikolaidis N, Palakidis K. Three computer methods to reconstruct pulpal blood vessels and nerves. J Endodon 1995;21:501-4.

PURPOSE: To present 3 methods utilized for creating a 3-dimensional (3-D) reconstruction of the neurovascular pulpal plexus.

M&M: 5 maxillary premolars from young patients were extracted, fixed, decalcified, sectioned, and stained for light microscopic examination. Slice images were digitized and stored on computer. After image acquisition, image enhancement, alignment of the section images, interpolation, and contour following were performed, 3-D visualization was produced on the computer screen.

RESULTS: Histologically, the authors tried to follow the central neurovascular bundle with its nearest branches throughout the total number of serial cross-sections. *Representation by means of a stack of slices* is a simple projection with each slice slightly translated with respect to the previous one. Depth impression is imparted by changing shades of gray, allowing the user to select various viewing angles, or by assigning colors to structures, whose brightness changes with depth. *Volume representation* reconstructs the entire object volume, and performs some sort of segmentation (cut-out) of the internal structure, while retaining visual information about surrounding tissues. *Surface representation* utilizes a method termed tiling, ie covering the surface defined by the contours with polygons.

C&C: Individual slices obtained by physical sectioning give little information regarding the relative position of many cross-sections, and consequently of the 3-D structure of the objects. Furthermore, brightness problems, complex shapes of the structures, and the deformations caused by the sectioning process, all contribute to difficulties of using histologic images for 3-D reconstruction. Unfortunately, computer tomography technology is not quite ready for the microscope. Each of the methods discussed was partly successful at providing one form of 3-D illusion. Future studies of the microanatomy of pulpal structures may use 3-D reconstruction technology such as this.

**October 1995
Bates**

Christopher F.

Evaluation of the seal of various amalgam products used as root-end fillings

Johnson JR, Anderson RW, Pashley DH. Evaluation of the seal of various amalgam products used as root-end fillings. J Endodon 1995;21:505-8.

PURPOSE: To evaluate longitudinally the sealing qualities of various commercial amalgams, both dry and blood contaminated, in root-end fillings.

M&M: 121 extracted human teeth were used, single-rooted anterior and premolar teeth and palatal roots of max molars. The roots were cleaned and shaped, and 3-mm length cylindrical root-end preparations were made along the long axis with a slow-speed handpiece. Roots were randomly separated into 11 groups of 11, attempting to place like numbers of similar-sized roots into each group. The following 5 amalgams were tested: Tytin, Dispersalloy, Valiant PhD, Permite C, and New True Dentalloy. Zinc contents were measured at 0.03%, 0.97%, 0.04%, 0.18%, and 0.93%, respectively. Each amalgam brand had one group in which it was tested dry, and one in which it was tested in a prep filled with human blood. The fluid filtration method was used to measure microleakage. Measurements were obtained at 1, 2, 4, 8, 12, and 24 wk after placement of root-end fillings.

RESULTS: Tytin placed dry had the greatest leakage at each measurement period. Permite C placed in a blood-contaminated preparation consistently had 1 of 3 lowest leakage rates. Dispersalloy had high leakage rates when placed dry and showed the greatest difference between wet and dry leakage. Valiant PhD and New True Dentalloy generally had low leakage rates. Blood contamination did not seem to have an adverse effect on sealing ability; in fact, in most instances, blood-contaminated groups showed less leakage than dry groups.

C&C: This study showed that the brand of amalgam used can make a sig difference in the seal achieved (in vitro).

**October 1995
Hall**

Michael

Longitudinal evaluation of the microleakage of dentin bonding agents used to seal resected root apices

Vignaroli PA, Anderson RW, Pashley DH. Longitudinal evaluation of the microleakage of dentin bonding agents used to seal resected root apices. J Endodon 1995;21:509-12.

PURPOSE: To measure the sealing ability of four dentin bonding agents as root-end sealants and to evaluate the effect of contamination with blood on the seal.

M&M: 80 single-rooted teeth were decoronized, prepared to a #50 file at working length, step-back flared, and apically resected of 3 mm at a 45° bevel. The canals were obturated with gutta-percha (and no sealer), flush with the resected end, and each root was attached to a fluid filtration measurement system. Initial microleakages were obtained at this time to ensure samples displayed leakage. All roots were assigned into two groups (dry vs contaminated) of 40 each. Group 1 was divided into 4 material subgroups: 1A - Amalgambond (AMB); 1B - Scotchbond Multi-Purpose (SMP); 1C - Prisma Universal Bond 3 (UB3); and 1D - All-Bond 2 (AB2). Group 2 was similarly divided and tx'd; however, the root-ends were contaminated with human blood for 5 min, and wiped dry prior to tx. All materials were applied directly to the resected root end without a cavity preparation. Microleakage measurements were obtained at 1, 2, 4, 8, 12, and 24 wk after placement of the bonded materials.

RESULTS: All dentin bonding agents significantly reduced apical microleakage compared with prebonded controls at all time intervals. Blood contamination did not significantly affect the sealing ability of AMB, SMP, or UB3 throughout the study. The blood-contaminated AB2 leaked significantly more than uncontaminated AB2, through the duration of the study.

C&C: In certain cases, following a root-end resection, the operator is satisfied with the resultant gutta-percha fill and decides not to prepare a cavity preparation. An improved seal may result in such cases if a dentin bonding agent is properly applied. As root-end sealants, blood contamination did not affect the seal of AMB, SMP, or UB3. Except for UB3, the materials used here maintained their integrity throughout the study. Andreasen et al. (1993) have shown Sharpey's fibers and cementum deposited in intimate contact with root-end composite, and Rud et al. (1991) have shown better healing with Gluma bonding agent and composite than amalgam.

**October 1995
Bates**

Christopher F.

Antimicrobial and toxic effects of established and potential root canal irrigants

Yesilsoy C, Whitaker E, Cleveland D, Phillips E, Trope M. Antimicrobial and toxic effects of established and potential root canal irrigants. J Endodon 1995;21:513-5.

PURPOSE: To compare NaOCl at various concentrations to other potential irrigants.

M&M: Irrigants tested included NaOCl (5.25% (positive control), 2.5%, and 0.5%); Peridex; chlorhexidine gluconate (CG) (0.12%); alcohol (11.6%); Thera-sol; and physiological saline (negative control). Four microorganisms were used: *Streptococcus mutans* (Gram + aerobe); *Peptostreptococcus micros* (Gram + anaerobe); *Prevotella intermedius* and *Porphyromonas gingivalis* (Gram-negative anaerobes). Two studies were done; an in vitro test used paper disks saturated with test solutions placed on agar plates containing test bacteria. Zones of inhibition were measured. The in vivo study used subcutaneous tissue of guinea pigs to assess short-term toxicity. Test solutions (0.1 ml) were injected into the backs of the animals and animals were killed at 2 h, 2 days, and 2 wk, after which the tissue was examined histologically for inflammation.

RESULTS: The in vitro results showed 5.25% NaOCl to be effective against all microorganisms, while saline was ineffective. Alcohol had some antibacterial activity against *S mutans*, but was ineffective against the rest. Decreased concentrations of NaOCl resulted in decreased antibacterial effects. Peridex, CG, and Thera-sol produced effects similar to 5.25% NaOCl. The in vivo results showed that most solutions produced little to no inflammation at 2h and moderate inflammation at 2 days. At 2 wk, inflammation was absent except for 5.25% and 2.5% NaOCl and CG.

C&C: The results showed that Peridex, CG, and Therasol had similar antibacterial effects as full strength NaOCl, with little tissue toxicity, and therefore could be used as alternative canal irrigants. However, 5.25% NaOCl was no more toxic than the other materials and was as effective or more so as an antibacterial; what is most important, it costs much less than the other solutions. So, if used carefully and not expressed beyond the apex, NaOCl (full strength) remains #1!!

**October 1995
Hall**

Michael

Radiovisiography versus conventional radiography for detection of small instruments in endodontic length determination. II. In vivo evaluation

Ellingsen MA, Hollender LG, Harrington GW. Radiovisiography versus conventional radiography for detection of small instruments in endodontic length determination. II. In vivo evaluation. J Endodon 1995;21:516-20.

PURPOSE: To determine whether the radiovisiography (RVG) imaging system offers any advantages over conventional radiographs (CR's) for the identification of endodontic file tips in relation to the radiographic apex during working length determination.

M&M: 22 patients received endodontic therapy on maxillary molars. A size #8 or #10 K-type file was introduced into the mesiobuccal canal, to the level estimated to be flush with the apical foramen. Both Kodak D- and E-speed films were taken, processed, and compared for clarity of the small file tip. RVG images were created and altered to allow several views: original unenhanced, enhanced, negative-to-positive conversion, and the zoom feature in both the standard and in the negative-to-positive modes. Each of the 5 RVG images was compared with the 2 CR images for detail and visibility of the file tip in relation to the apex by two evaluators. D- and E-speed radiographs were similarly compared to one another. Accurate identification of the position of the small file tips was confirmed during instrumentation of the canals.

RESULTS: D-speed radiographs were found to be superior to each of the 5 RVG images (overall being better 75% of the time). RVG was statistically equal to E-speed radiographs in the negative-to-positive conversion/zoom, the standard zoom, the negative-to-positive conversion, and the enhanced modes. RVG in the original image was of significantly lesser quality than the E-speed films. Accurate identification of the small file tips was achieved on 95% of the D-speed radiographs, when using magnification, and on 70% of the E-speed radiographs. The most accurate mode of RVG was zoom in negative-to-positive conversion (95%). D-speed radiographs were judged better than E-speed radiographs 100% of the time.

C&C: Broad mesiobuccal roots, such as those used in this study, tend to obscure the tips of small files on radiographs. Enlarging canals to a minimum of size #15 before canal length determination certainly carries the potential to ledge or be blocked out. The findings of this clinical study suggest that in the vast majority of cases, size #8 and #10 files can be used for working length determination in small calcified canals of maxillary molars, when D-speed radiographs are viewed with magnification. D-speed film is definitely the conventional film of choice, and radiovisiography simply does not rate with D-speed film for establishing working length with small files.

**October 1995
Bates**

Christopher F.

Ten-year in vitro assessment of the surface status of three retrofilling materials

Biggs JT, Benenati FW, Powell SE. Ten-year in vitro assessment of the surface status of three retrofilling materials. J Endodon 1995;21:521-5.

PURPOSE: To evaluate the condition of in vitro retrofillings of amalgam, glass ionomer cement, and EBA cement after 10 yr of storage in physiological saline.

M&M: 60 extracted central incisors were divided into 2 groups of 30, half root-resected with a high-speed handpiece (HSH) and half with a slow-speed handpiece (SSH). Root-end preps were made with a #2 round bur, and root-end fillings of EBA cement and Ketac cement were each placed in 10 teeth in the HSH and 10 in the SSH groups. Ten more in the HSH group were filled with zinc-containing Dispersalloy amalgam, and 10 in the SSH group with zinc-free Dispersalloy. The teeth were then stored in physiological saline for 10 years and then removed, photographed, and evaluated for marginal discrepancies, root crazing, staining, voids, and roughness.

RESULTS: Ketac cement showed the most severe marginal discrepancies, followed by EBA cement, zinc-free and zinc-containing amalgam. Zinc-free amalgam had the most root crazing, followed by zinc-containing amalgam, EBA cement, and Ketac cement. Ketac cement stained roots the most, followed by zinc-free and zinc-containing amalgam, and EBA cement. Voids were seen most often in the Ketac cement group, followed by EBA cement, zinc-free, and zinc-containing amalgams. Roughness was rated the most for zinc-free amalgam, followed by Ketac cement, zinc-containing amalgam, and EBA cement. Zinc-free amalgam rated worse in all categories than zinc-containing amalgam.

DISCUSSION: This study was not well-conceived, arising out of one of the authors' preparation for research after acceptance for graduate training. The teeth were not instrumented or obturated, and initial photographs of the root-end fillings were not taken. Basically, the teeth were stored and forgotten, then rediscovered and examined after a 10-yr storage period. The effects of long-term storage in saline of root-end filling materials were able to be evaluated, however. Rater agreement when evaluating marginal integrity, staining, and roughness was poor, while agreement when judging the number of voids or cracks was better.

C&C: Overall, EBA cement performed as well as amalgam when evaluated within the parameters of this study, although it ranked inferior in marginal integrity and voids, which are associated with solubility. Glass ionomer performed rather poorly all around. Due to poor rater agreement on marginal integrity, roughness, and staining, firm conclusions regarding those variables were not possible. Although not much can be gained from this study, it at least does not detract from the use of Super EBA as a root-end filling material.

**October 1995
Hall**

Michael

Unusual foreign objects in the root canal

Walvekar SV, Al-Duwairi Y, Al-Kandari AM, Al-Quoud OA. Unusual foreign objects in the root canal. J Endodon 1995;21:526-7.

REVIEW: Removal of foreign objects from the root canal is often very difficult. Various techniques over the years have been described to remove these obstructions: use of Stieglitz pliers, solvents used with files, a dental needle/thin steel wire loop assembly used with a small hemostat, additional removal of internal root structure, and activation of an ultrasonic scaler or Cavi-Endo device.

CASE 1 - A 19-yr-old female with a broken sewing needle in the apical root canal space of tooth #7. A #8 K-file was used to bypass the broken object on its mesial and distal sides. #10 and #15 K-files were then used to bypass the object. Next, 2 Hedstrom files (#20) were inserted along the broken needle on opposite sides, and the files were pulled together. This procedure was repeated 3-4 times, at which time the object finally was retrieved. **CASE 2** - A 24-yr-old male with a broken bur head firmly lodged in the mid-canal region of tooth #8. A #8 K-file was used to bypass the bur head; this was repeated by #10 and #15 K-files. Finally, two #20 Hedstrom files were engaged alongside of the bur head and pulled together. The object was dislodged successfully after 3-4 attempts.

C&C: Removal of unusual foreign objects in root canals is often tedious. Although time-consuming, bypassing the obstructed object with a fine K-file is important for ultimate removal. This procedure should be attempted before the use of any mechanical devices, which require removal of tooth structure.

**October 1995
Bates**

Christopher F.